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TECHNICAL REPORT 9202

Performance of Selected Fabrics on the Decontaminable Litter and Litter Mattress to Correct a Problem of Unexpected Sliding during Patient Loading on a C-9 (Nightingale) Aircraft

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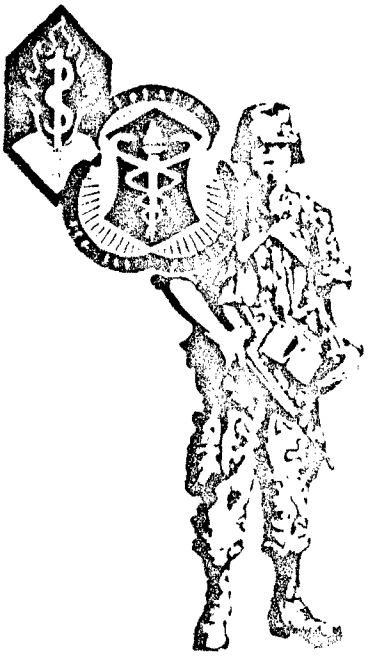

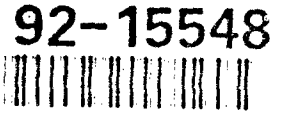

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During evaluation of the decontaminable litter, Air Force personnel noted that a patient laying on a vinyl litter mattress slid unexpectedly while being carried up a 19 degree loading ramp of the C-9 (Nightingale) aircraft. To address this problem, a number of selected materials were fabricated into litter and mattress covers. The slipperiness of each product was measured by placing a subject on the test litter with or without a test mattress, elevating one end of the litter until the subject began to slide, and measuring the incline (slide) angle. The data show that the vinyl mattress will slide on the polypropylene mesh cover of a decontaminable litter at 16-17 degrees, whereas the same mattress on the cotton duck cover of the standard litter will slide at 23 degrees. The cotton duck cover has been replaced with nylon duck which is as slippery as the polypropylene mesh; and it generates a noticeable static electric charge when the vinyl mattress rubs against it. The problems of sliding and static electricity were significantly reduced by replacing the vinyl cover of the mattress with a commercial hospital grade fabric ('LECTROLITE^{R}) that is electroconductive and antislip. No fabric for the litter cover performed as well as cotton duck in this study; however, a polypropylene honeycomb material would be a better alternative to the nylon duck.

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INTRODUCTION.

The importance of litters for evacuating casualties from the battlefield has not changed in spite of the sophisticated weaponry that has evolved during this century. The standard canvas litter found with U.S. forces in Operation Desert Shield/Desert Storm is remarkably similar to that used during World War I. During both conflicts, the threat or actual use of chemical warfare agents (CWA) demonstrated that medical evacuation can be compromised by a litter that is readily contaminated and very difficult to decontaminate.

In accordance with Final Draft Letter Requirement (LR) for Litter, Folding (ACN 64207), a research and development program was initiated at the U.S. Army Biomedical Research and Development Laboratory to produce a litter that resists physical entrapment of and degradation by CWA and is easy to decontaminate. The result of this effort was the Litter, Rigid Pole, Decontaminable (NSN 6530-01-290-9964 [decon litter]). The decon litter featured aluminum poles treated with Chemical Agent Resistant Coating, retractable nylon handles, ethylene propylenediene monomer (EPDM) rubber securing straps, and a woven monofilament polypropylene mesh cover.

Whereas laboratory and field tests demonstrated that the decon litter met the essential characteristics of the LR, testing by U.S. Air Force personnel at Scott AFB uncovered a potential hazard in the design of the cover material. As described in a letter from Lt Col Sandra L. Stanley, Chief, Aeromedical Standards Evaluation/Training/Equipment, patients resting on a vinyl covered pad (Litter Mattress, NSN 6530-00-137-3016) slid as much as one foot on the decon litter when enplaning/deplaning from a C-9 aircraft.

As a result of this finding, a new effort was undertaken to assess the slipperiness of the polypropylene cover on the decon litter as well as the

vinyl cover of the mattress. A number of different synthetic materials were obtained and fabricated into litter and mattress covers. Their slipperiness was evaluated by placing a human subject on the litter with or without a mattress and measuring the maximum angle to which the litter could be elevated before the subject began to slide. This communication reports the findings of the study.

MATERIALS AND METHODS.

Characteristics of the fabrics evaluated in this study are listed in Tables I and II. Experimental litter covers were made from nylon, polypropylene or saran (polyvanilladine chloride). These polymers have excellent qualities that lend to their extrusion as monofilament yarn and production into woven fabrics. The last two polymers also show excellent resistance to both CWA and decontaminating solutions ("Chemical Warfare Materials Compatibility Database," Chemical/Biological Information Analysis Center, Aberdeen Proving Ground, MD).

Litter covers were sewn as illustrated in Fig. 1 and fastened to the decon litter frames without special modification. As noted in the Results, some covers were sewn without Z-folds: overlapping layers of fabric sewn as reinforcement in the cover opposite the spreader bars. These covers were made from fabrics that were either too stiff for sewing Z-folds or were judged sufficiently strong that reinforcement was not necessary.

To evaluate fabrics for the mattress cover, candidate materials were sewn into covers that fitted snugly over an intact pad. One laminated vinyl product, 'LECTROLITE^{R} (Herculite Products, Inc., York, PA), was selected for additional testing because of its desirable characteristics (see Appendix A). Litter mattresses were sent to a commercial vendor (M-C Industries, Inc., Belleville, KS) who replaced the vinyl covers with 'LECTROLITE^{R} material, using essentially the same fabrication techniques as found on the standard vinyl mattress: edges were heat sealed and a plastic pressure relief valve was glued to the fabric. Because 'LECTROLITE^{R} is dull black and the standard litter pad is international orange, two bright orange strips, four inches wide, were painted down the edges of some covers. It was reasoned that litter mattresses might

require some distinguishing marks for search and rescue operations, although there is no reference to such a requirement in MIL-P-36816, "Mattress, Litter."

To measure the slipperiness of cover materials, a simple test was devised. A human subject was placed on the litter, with or without a mattress; and one end of the litter was raised until the subject began to slide. The height of the litter was measured, and the incline angle (slide angle) was calculated as the inverse sine of this value divided by the length of the litter. To ensure reproducibility, the same subject was used throughout a series of experiments; and the subject was instructed to grasp the edges of the mattress to ensure that sliding occurred only between the mattress and the litter. Each observation listed in the Results is the average of triplicate measurements taken consecutively.

Two different methods were used to elevate the litter. During initial studies, the litter was raised manually and a person measured the height at which the subject began to slide. Whereas there was no means for controlling the rate of ascent, this did not appear to be a significant factor since the reproducibility of data between experiments was very good. With the same subject on the same standard litter with the same litter pad, the range of slide angles measured was 23 to 24 degrees.

The manual method for elevating the patient was replaced with a mechanical method. A test bed was constructed (see Fig. 2) so that one end of the litter was placed on the edge of an electo-hydraulic lift table (Model L52-36P, Southworth, Portland, ME) while the other end was free to move. The lift table provided a smooth, reproducible rate (about 2 in/sec) of elevation. As with the manual method, the lift table was stopped when the subject began to slide. The slide angle was measured directly from a calibrated scale adjacent to the lift table.

RESULTS

Evaluation of Materials for the Litter Cover.

Since the angle of the loading ramp of the C-9 aircraft is 19 degrees, particular attention was paid to identifying fabrics that retained the subject at slide angles equal to or greater than 19 degrees. Table I lists the materials that were evaluated as litter covers along with their slide angles. These data show that a subject lying directly on any litter cover could be elevated through 19 degrees without sliding. However, when the litter mattress was placed between the subject and the litter, slide angles decreased 4 to 10 degrees for all cover fabrics; and most fabrics failed to retain the mattress up to an angle of 19 degrees.

The cotton duck found on the standard litter and two fabrics made from saran did hold the subject and mattress on the litter beyond 19 degrees. One fabric (Table I, Sample 12, McMaster Carr, cat. no. 9211T21) was a light weight screen. After limited testing, the yarn began to break down revealing a saran coating over polyester fibers. Because the fibers could trap and wick CWA, this material was deemed unsuitable for the decon litter and was not evaluated further. The other material (Table I, Sample 14, Lumite, style 60563000) was made from saran monofilament yarn in a three dimensional honeycomb weave. This fabric was developed for the military as an insert for combat boots.

A significant finding in this series of experiments was the poor performance of the nylon duck cover (Table I, Sample 2) that is currently found on the standard litter. This material was as slippery as the polypropylene mesh; and as the mattress slipped down the litter, a static electric discharge could be heard. In a dark room the discharge was readily visible as a row of sparks moving with the trailing edge of the mattress as it passed over the nylon cover.

Evaluation of Materials for the Litter Mattress.

As listed in Table II, four mattress covers were evaluated on five different litter covers: cotton duck, nylon duck, polypropylene mesh, polypropylene honeycomb weave, and saran honeycomb weave. The data show that the mattress made with "LECTROLITE^{R} (black surface on the outside and unpainted) significantly reduced subject slippage on all litter covers. Compared to the vinyl material, the "LECTROLITE^{R} demonstrated a 67% increase in the slide angle on the cotton duck cover; and it improved the slide angle of all other litter covers by >100%. In addition, when the "LECTROLITE^{R} mattress did slip on the nylon duck, there was no overt indication that a static electric charge was created.

Table III lists the results of testing 'LECTROLITE^{R} material after it was fashioned into mattresses and painted with orange strips along the edges. The addition of the stripes reduced the slide angle an average of 17% compared to unpainted fabric. However, on the litter covers tested, all slide angles were in excess of 30 degrees.

Evaluation of Litter Covers with the Subject in Regular Weight or Summer Weight Battle Dress Uniforms.

Because the slide angle of the litter cover is dependent upon the material in contact with it, slide angles were measured with the test subject wearing a regular weight or a summer weight battle dress uniform (BDU). Data in Table IV show that the subject wearing either weight BDU experienced a slide angle of less than 19 degrees when placed directly on litters with the nylon duck or the polypropylene mesh covers. However, when the polypropylene honeycomb weave was used for the cover, the slide angle increased significantly: 22 degrees with regular weight BDU's and 24 degrees with summer weight BDU's. The presence or absence of a Z-fold appeared to have no effect on the slide angle of

presence or absence of a Z-fold appeared to have no effect on the slide angle of either saran or polypropylene honeycomb weave covers.

The slide angle was also measured with the subject lying unsecured on the mattress and the mattress secured to the litter. On the vinyl mattress, the subject began to slide at 22 and 26 degrees for regular weight and summer weight BDU's respectively. On 'LECTROLITE^{R}, the slide angle increased to 36 degrees for both uniforms. Whereas the patient is more prone to sliding on the vinyl than the 'LECTROLITE^{R} mattress, either mattress on a litter would begin to slide before the patient moved on the mattress.

DISCUSSION

The LR defining the decon litter lists as an essential characteristic: "Be constructed of materials which shall not cause safety or health hazards to patient or using personnel." Air Force personnel discovered that a patient carried up a 19 degree slope tended to slide when resting on a vinyl litter mattress and decon litter, calling into question the safety of the polypropylene mesh cover used on the decon litter. Results reported in this communication show that this problem exists along with others, but excellent solutions are available.

Regardless of the cover material, a patient will slide if a litter is angled too steeply. Field Manual 8-35, "Evacuation of the Sick and Wounded," contains chapters on securing and transporting patients over uneven terrain. However, it is reasonable to expect that the decon litter should perform better than the unit it replaces in most aspects; and the data show that the polypropylene mesh cover of the decon litter is slipperier than the cotton duck cover, particularly when used with the litter mattress.

In addressing this problem, there are mitigating circumstances that must be considered. Most notable is the fact that the standard litter is now produced with a nylon duck cover which is as slippery as the polypropylene mesh. In addition, an essential characteristic of the vinyl cover on the litter mattress is that it be "... embossed and slip-inhibiting." Our data show that the mattress significantly reduced the slide angle of all litter cover fabrics; i.e., it made the litters more slippery. Clearly, in the ongoing acquisition of litters and mattresses, the selection of fabrics has been based upon issues other than the propensity of patients to slide during transportation.

Air Force personnel identified the slippage problem while participating in a planned evaluation of the decon litter during its development. Data in this

communication show that this problem is not isolated to the decon litter and mattress. Comparable slippage should be expected when the vinyl mattress is used with the new nylon duck covered litter; and there may be an additional hazard from static electric discharge. In short, the problem is not a research and development issue to be solved in the future, but one that needs to be addressed now.

With respect to the litter cover, the essential characteristics described in the LR for the decon litter accurately reflect the kind of fabric that should be used for battlefield conditions: lightweight, strong, resistant to CWA and decontaminating solutions, nonflammable, porous to liquids, functional in temperature extremes, and safe for the patient and using personnel. All of these essential characteristics can be met by a fabric with an open-weave and constructed from a monofilament polymer, such as polypropylene or saran.

The qualities of these plastics that make them strong, resistant to CWA, and easy to clean also make them slippery. Our data show that saran is less slippery than polypropylene. It also has a "better hand," i.e., it feels softer to the touch. However, the saran material provided by the manufacturer was designed for boot inserts. It lacks the coloring agents, UV blockers, and other additives required for the litter cover. According to the manufacturer, the tensile strength of the saran honeycomb is 165 x 170 lb/in (warp direction by fill direction) which is about 50% less than the polypropylene honeycomb (295 x 270 lb/in), and it weighs almost twice as much (13.0 oz/sq yd vs. 6.9 oz/sq yd). A new development effort would be required to optimize the saran formulation for a suitable litter cover.

The polypropylene honeycomb was produced from the same monofilament yarn used for the mesh cover of the decon litter; therefore, characteristics such as flammability, resistance to CWA, and performance in temperature extremes are

identical. There are important differences between the two fabrics. By weaving the polypropylene in a honeycomb pattern, the tensile strength of the fabric increased from 190 x 150 lb/in to 295 x 270 lb/in, as reported by the manufacturer. Moreover, the slide angle for a subject in BDU's and lying on the honeycomb fabric (22 to 24 degrees) was 20 to 25% greater than when lying on the mesh fabric (17 to 18 degrees).

One problem that was not solved by the polypropylene honeycomb weave was its slipperiness when used in conjunction with the vinyl mattress. Data in Table I show that regardless of the polypropylene fabric tested, the slide angle of the subject on the vinyl mattress was 16 to 18 degrees. These observations suggest that the slipperiness of the polypropylene cannot be reduced by roughing the surface or changing the style of weave. To change the coefficient of friction of polypropylene, tackifiers or fillers can be mixed with the polymer. However, there is no simple means for formulating the ideal compound, and a new development effort would need to be undertaken.

A more immediate solution to the slippage problem is to replace the vinyl cover on the litter mattress with a fabric like 'LECTROLITE® which is commercially available and specifically designed for covering medical pads and mattresses. Our data show that this fabric improved the slide angles of all litter cover materials and it prevented or significantly reduced the build up of static electricity. A mattress made from this kind of material would increase the margin of safety for transporting patients rather than decreasing it.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to address a safety problem discovered when patients began to slip off the decon litter while lying on a vinyl litter mattress and being carried up the loading ramp of the C-9 aircraft. During the course of this investigation, we demonstrated that the polypropylene mesh cover on the decon litter is more slippery than the cotton duck cover on the standard litter. However, the cotton duck has been replaced with a nylon duck which is as slippery as the polypropylene mesh. In addition, a noticeable static electric charge may be created when the litter mattress slides on the nylon, creating yet another safety issue.

The polypropylene yarn used for the decon litter mesh cover was woven in a honeycomb pattern which proved to be stronger and more textured than the mesh. Changing the weave of the fabric also increased the slide angle when the subject was wearing BDU's and lying directly on the litter, but it did not change the slide angle when the subject was lying on the litter mattress.

The slipperiness between the litter and the mattress was reduced only when different materials were used. Saran monofilament performed better than polypropylene for the litter cover; and 'LECTROLITE^{R} performed significantly better than the vinyl currently used on the mattress. In addition, the 'LECTROLITE^{R} did not propagate a static electric charge on the nylon duck cover. Use of saran for the litter cover or altering the slipperiness of the polypropylene will require new development efforts including CWA testing; whereas, 'LECTROLITE^{R} and comparable products are commercially available and easily fabricated into litter mattresses.

It is recommended that extreme caution be used when transporting patients on the nylon duck-covered standard litter with the vinyl litter mattress. The

hazards associated with using the mattress on this litter should be corrected as soon as possible. This can be accomplished by changing the cover on the mattress to a hospital grade fabric, such as 'LECTROLITE^{R} that is anti-slip and anti-static. Moreover, the nylon duck should be replaced with a less slippery fabric as well. The polypropylene honeycomb mesh described in this communication is an excellent candidate because it is chemically resistant, easy to clean, and commercially available.

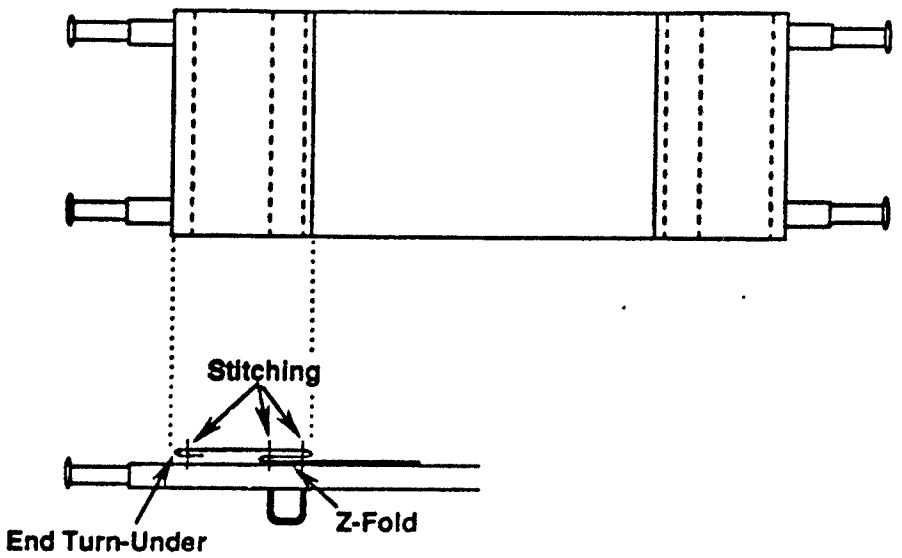

FIGURE 1. *An illustration of the Litter, Rigid Pole, Decontaminable, showing the configuration of the litter cover over the poles and the Z-fold in the cover fabric.*

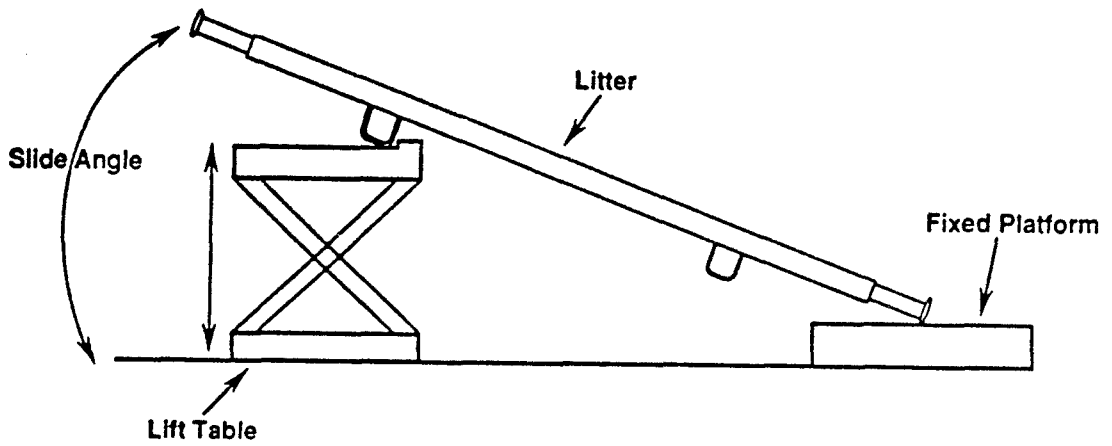

FIGURE 2. *An illustration of the electro-hydraulic lift configured to elevate one end of a test litter for determining the slide angle.*

TABLE I: *A determination of the angle at which a human subject begins to slide on different litter covers with and without the litter mattress. The test subject was 73" and 160 lb, he wore a cotton tee shirt and blue jeans during the tests, and he secured himself to the mattress by holding its edges. One end of the litter was raised manually until the subject or the mattress began to slide.*

FABRICS FOUND ON THE STANDARD LITTER

1. Fabric: Cotton duck in accordance with CCC-C-419, Type 10, No. 10, used on standard litter.
   Source: unknown
   Slide angle of subject on litter: 28 degrees
   Slide angle with mattress on litter: 23 degrees
   Observations: Slide angle with or without mattress exceeds 19 degrees. Slight static electric discharge was observed as mattress slid on the litter cover. Fabric is no longer available as a standard item for the litter.

2. Fabric: Nylon Duck, MIL-C-7219, Type III, Class 3.
   Source: Unknown
   Slide angle of subject on litter: 21 degrees
   Slide angle with mattress on litter: 17 degrees
   Observations: Replacement material for the cotton duck cover on the standard litter. Slide angle with the mattress does not exceed 19 degrees. As the mattress slid over the nylon cover, a very noticeable discharge of static electricity could be heard or seen in a dark room.

POLYPROPYLENE FABRICS

3. Fabric: Polypropylene mesh, 24 x 20, calendered. Style 6068102.
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 24 degrees
   Slide angle with mattress on litter: 16 degrees
   Observations: Cover material used on the decon litter. Slide angle with mattress does not exceed 19 degrees.

4. Fabric: Polypropylene mesh, 24 x 20, calendered, and roughened. Same as sample 3 but treated with Type-A proprietary process to roughen the surface.
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 22 degrees
   Slide angle with mattress on litter: 16 degrees
   Observations: Slide angle was not significantly different from unroughened material.

5. Fabric: Polypropylene mesh, 24 x 20, calendered, and roughened. Same as sample 3 but treated with Type-B proprietary process to roughen the surface.
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 21 degrees
   Slide angle with mattress on litter: 17 degrees
   Observations: Slide angle was not significantly different from unroughened material.

TABLE I. *Continued.*

6. Fabric: Polypropylene honeycomb weave, 29 x 28. Style PDH 62630 (Type B weave).
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 26 degrees
   Slide angle with mattress on litter: 17 degrees
   Observations: Slide angle with mattress does not exceed 19 degrees.

7. Fabric: Polypropylene square weave, course. Style 69633000
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 24 degrees
   Slide angle with mattress on litter: 17 degrees
   Observations: Slide angle with mattress does not exceed 19 degrees.

8. Fabric: Polypropylene square weave, fine. Style 6025900
   Source: Lumite, Norcross, GA
   Slide angle of subject on litter: 22 degrees
   Slide angle with mattress on litter: 15 degrees
   Observations: Slide angle with mattress does not exceed 19 degrees.

9. Fabric: Molded polypropylene sheet, ribbed pattern with square perforations. Cat. no. 9265T61.
   Source: McMaster-Carr, New Brunswick, NJ.
   Slide angle of subject on litter: 27 degrees
   Slide angle with mattress on litter: 15 degrees
   Observations: With elevated ribs perpendicular to slide path, the slide angle with mattress does not exceed 19 degrees.

10. Fabric: Polypropylene duck, course weave. Style 60737
    Source: Lumite, Norcross, GA
    Slide angle of subject on litter: 24 degrees
    Slide angle with mattress on litter: 17 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

11. Fabric: Polypropylene duck, smooth weave. Style 60735
    Source: Lumite, Norcross, GA
    Slide angle of subject on litter: 22 degrees
    Slide angle with mattress on litter: 18 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

SARAN FABRIC

12. Fabric: Saran mesh, 18 x 14. Cat. no. 9211T76.
    Source: McMaster-Carr, New Brunswick, NJ
    Slide angle of subject on litter: 28 degrees
    Slide angle with mattress on litter: 21 degrees
    Observations: Slide angles with or without mattress exceeded 19 degrees. Fabric yarn broke during testing revealing a saran coating over polyester filaments.

TABLE I. *Continued.*

13. Fabric: Saran mesh, 20 x 22. Style 60107000
    Source: Lumite, Norcross, GA
    Slide angle of subject on litter: 27 degrees
    Slide angle with mattress on litter: 17 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

14. Fabric: Saran honeycomb weave, 29 x 28. Style 60563000
    Source: Lumite, Norcross, GA
    Slide angle of subject on litter: 27 degrees
    Slide angle with mattress on litter: 21 degrees
    Observations: Slide angles with or without mattress exceed 19 degrees.

15. Fabric: Saran honeycomb weave, 29 x 28. Style PDH 62648.
    Source: Lumite, Norcross, GA
    Slide angle of subject on litter: 26 degrees
    Slide angle with mattress on litter: 18 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

OTHER FABRICS

16. Fabric: Cordura nylon duck
    Source: unknown
    Slide angle of subject on litter: 24 degrees
    Slide angle with mattress on litter: 18 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

17. Fabric: Nylon mesh, 20 x 20. Cat. no. 9211T21
    Source: McMaster-Carr, New Brunswick, NJ
    Slide angle of subject on litter: 21 degrees
    Slide angle with mattress on litter: 17 degrees
    Observations: Slide angle with mattress does not exceed 19 degrees.

TABLE II. *A determination of the angle at which a human subject begins to slide when litter mattresses with different covers were placed on litters with different covers. The test subject was 73" and 160 lb, he wore a cotton tee shirt and blue jeans during the tests, and he secured himself to the mattress by holding its edges. One end of the litter was raised manually until the subject or the mattress began to slide.*

1. Mattress fabric: Vinyl (polyvinylchloride), L-P-375, Type II, Class 2, 7 mils.
   Source: unknown, standard cover for Litter Mattress

Litter Cover	*Slide Angle (degrees)*
Cotton Duck	24
Nylon Duck	16
Polypropylene Mesh	18
Polypropylene Honeycomb	16
Saran Honeycomb	21

2. Mattress fabric: 'LECTROLITE®, Duotone, 9.6 oz/sq yd. Black side out.
   Source: Herculite Products, Inc., York, PA

Litter Cover	*Slide Angle (degrees)*
Cotton Duck	40
Nylon Duck	39
Polypropylene Mesh	40
Polypropylene Honeycomb	39
Saran Honeycomb	44

3. Mattress fabric: 'LECTROLITE®, Duotone, 9.6 oz/sq yd. Green side out.
   Source: Herculite Products, Inc., York, PA

Litter Cover	*Slide Angle (degrees)*
Cotton Duck	24
Nylon Duck	19
Polypropylene Mesh	19
Polypropylene Honeycomb	19
Saran Honeycomb	22

4. Mattress fabric: 'Staphchek 20®, 10.6 oz/sq yd,
   Source: Herculite Products, Inc., York, PA

Litter Cover	*Slide Angle (degrees)*
Cotton Duck	24
Nylon Duck	19
Polypropylene Mesh	20
Polypropylene Honeycomb	18
Saran Honeycomb	19

TABLE II. *Continued.*

5. Mattress fabric: Polyurethane coated cloth, MIL-C-83489, Type II, plain weave, 4.3 oz/sq/yd. Polyurethane side out.
   Source: M-C Industries, Inc., Belleville, KS

Liner Cover	*Slide Angle (degrees)*
Cotton Duck	17
Nylon Duck	12
Polypropylene Mesh	14
Polypropylene Honeycomb	12
Saran Honeycomb	13

TABLE III. *A determination of the angle at which a human subject begins to slide when litter mattresses with either the vinyl cover or the 'LECTROLITE® cover were placed on litters with different covers. The test subject was 71" and 185 lb, he wore a battle dress uniform during the tests, and he secured himself to the mattress by holding its edges. One end of the litter was raised using an electro-hydraulic lift until the mattress began to slide.*

	SLIDE ANGLE (degrees)	
Litter Cover	*on Vinyl*	*on 'LECTROLITE®*
Cotton Duck	24	36
Nylon Duck	18	32
Polypropylene Mesh	18	32
Polypropylene Honeycomb (Z-fold)	17	33
Polypropylene Honeycomb (w/o Z-fold)	18	34
Saran Honeycomb (Z-fold)	19	36
Saran Honeycomb (w/o Z-fold)	20	36

TABLE IV. *A determination of the angle at which a human subject begins to slide while wearing the regular weight or the summer weight battle dress uniform (BDU) and placed on litters with different covers. The test subject was 71" and 185 lb. One end of the litter was raised using an electro-hydraulic lift until the mattress began to slide.*

	SLIDE ANGLE (degrees)	
Litter Cover	*Regular BDU*	*Summer BDU*
Cotton Duck	27	27
Nylon Duck	18	18
Polypropylene Mesh	17	18
Polypropylene Honeycomb (Z-fold)	21	22
Polypropylene Honeycomb (w/o Z-fold)	22	24
Saran Honeycomb (Z-fold)	21	22
Saran Honeycomb (w/o Z-fold)	21	21

APPENDIX A

'LECTROLITE

Confidential price list
Revised, Jan. 21, 1991

Electrically Conductive, Antibacterial Fabric

ROLL GOODS						PRICE PER LINEAR YARD				
STYLE	STANDARD COLORS	WEIGHT-OZ. PER SQ. YD. (AVG.)	STD. ROLL ±15% (YARDS)	FABRIC WIDTH (MIN.)	APPROX. ROLL WEIGHT	MFRS. LIST PRICE	50 TO 500 YDS.	500 TO 1000 YDS.	1000 TO 2000 YDS.	2000 TO 3000 YDS.
LECTROLITE® PREMIUM	black on blue	10.5	50	54"	51 lbs.	10.16	6.46	6.15	5.59	5.08
LECTROLITE® DUOTONE	black on green			39.5"	35 lbs.	7.80	4.96	4.71	4.29	3.90
				54"	51 lbs.	9.18	5.84	5.56	5.05	4.59

'LECTROLITE Mattress Binding Tape - minimum order: one package

Black	50 yds/roll	7/8" width	10 rolls/pkg.	51.96/pkg.

IMPORTANT:
To preserve electrical conductivity when joining together two sections of 'Lectrolite fabrics, black must be sewn to black. The conductive black face side of one section must be sewn in direct contact with the conductive black face side of the other section.

PRICES: F.O.B. Plant, York, Pa.
TERMS: 1/2% 10 days, net 30 days. Prices subject to change without notice.
ROLL GOODS: 50 yd. rolls may consist of two pieces – no length being less than 7 yds. Defects in roll will be flagged on the outer edge, with a 1/4 yd. allowance made for each major defect.
SLITTING: $.20 per linear yard, minimum charges $25.00.
UNIT PRICE/YD.: Total yardage of all grades of roll goods ordered will determine category of price per linear yard.
PACKAGING: Double-wrapped for safe shipment in extra-heavy kraft paper and bound with reinforced tape.
AVAILABILITY: From stock for immediate delivery.

'LECTROLITE® fabrics incorporate U.S. Patent No. 3,891,786 for "Electrically Conductive Sheeting."

staphCHEK

HERCULITE PRODUCTS, INC.

A Subsidiary of Health-Chem Corporation
P.O. Box 786, York, Pa. 17405
(800) 772-0036 • (717) 764-1191 • FAX: (717) 764-5211

'LECTROLITE.

LABORATORY REPORT

HERCULITE PRODUCTS, INC.
P.O. BOX 786, YORK, PA 17405
(800) 772-0036 • (717) 764-1191
FAX: (717) 764-5211

QLL5005, on the Qualified Laboratory List has been assigned to the Herculite Laboratory by the U.S. Government Defense Supply Agency (DPSC). The Laboratory is periodically examined and approved by the Defense Supply Agency for condition and accuracy of test apparatus, personnel competence and reliability in reporting test data.

JULY, 1991
SIDE 1 OF 2

SUBJECT: PERFORMANCE PROPERTIES OF 'LECTROLITE DUOTONE FABRIC, 9.6 OZ.
SCOPE: 'LECTROLITE ELECTRICALLY CONDUCTIVE, ANTIBACTERIAL, ANTISTATIC, FLAME RETARDANT, REINFORCED VINYL LAMINATE, WATER PROOF, TEAR RESISTANT FABRIC.

TABLE I

PROPERTY	TEST METHOD	TEST RESULTS CURRENT PRODUCTION	DESCRIPTION
BIOLOGICAL PROPERTIES			
ENVIRONMENTAL PROTECTION AGENCY EPA REGISTRATION NUMBER	Anti-microbial agent	42182-1	Registered with the E.P.A. for end use.
Antibacterial Activity, after accelerated aging, washing, and autoclaving. Reduction % Staph aureus (gram positive) Klebsiella pneumoniae (gram negative) Legionella pneumophilia (Legionnaire's Disease)	NYS 63 and NYS 63 (Mod.)	99.9+ 99.9+ 99.9+	Antibacterial agents are an integral part of the fabric. Fabric is self-deodorizing and self-sanitizing, inhibits the growth of most bacteria, fungus, mildew, and odor forming microbes. ANTIBACTERIAL FOR THE LIFE OF THE FABRIC.
Primary Skin Irritation Index	Draize Dermal Toxicity	0	Fabric is non-allergenic - does not cause toxic reactions and irritations.
PHYSICAL PROPERTIES			
Weight, oz. per sq. yd.	Fed. Std. 191 5041	9.6	Lightweight, high strength
Flame Resistance Vertical After flame and glow time, sec. Char Length, inches Cigarette Ignition	5903 & 16 CFR Part 1632 (FF4-72)	 0.3 4.3 Less Than 0.5"	Inherent Flame Resistance to minimize fire hazards Is registered with California Fire Marshal - passes NFPA-701 large scale test Classified as Class A (Barrier) materials
Breaking Strength, lbs.	5100	W 90 F90	Construction designed for Ticking Fabrics
Tear Strength, lbs.	5134	W 21 F 24	Excellent tear strength, punctures will not produce running rips.
Abrasion resistance, loss of initial breaking strength, percent	5304 & 5102	5	Highly durable, scuff and abrasion resistant, not affected by surface wear.

SUBJECT: PERFORMANCE PROPERTIES OF 'LECTROLITE FABRIC, 9.6 OZ.

JULY, 1991
SIDE 2 OF 2

PROPERTY	TEST METHOD	TEST RESULTS CURRENT PRODUCTION	DESCRIPTION
PHYSICAL PROPERTIES (cont'd.)			
Adhesion (peel), lbs./2 inches	5970	45	Resistant to delamination from flexing action of hospital bed.
Liquid Penetration Resistance, Waterproofness, Hydrostatic test, after accelerated aging, washing, and autoclaving, psi	5512	115	Constructed with non-penetrable surfaces. Liquid, body waste and hospital medicaments cannot penetrate
Slip Resistance, equal to Standard Fabric	HTM 4.2.6	Pass	Engineered finish provides non-skid anti-slip surface
ENVIRONMENTAL PROPERTIES			
Flexibility, Pliability and Hand Clark Stiffness at 20 °F, cm Cold Crease, °F	 5204 5874	 7.2 No cracking @ –15 °F	Soft and flexible to ensure patient's comfort
Extraction Resistance, Weight Loss % Soapy Water Alcohol	HTM 4.2.10	 6.5 3.0	Retains softness and flexibility - flexing agents do not leach out on washing
Staining and Penetration Resistance	HTM 4.2.11	Pass	No staining, penetration or other effects except slight discoloration: alcohol, oil, grease, perspiration (acid and alkaline) and urine
Blocking, scale rating	5872	2	Fabric releases readily from roll for fabrication
ELECTRICAL PROPERTIES			
Surface Resistivity ohms per unit square	NFPA 99 PARAS: 3-3.6.2.7 & 3-3.3.6.3	Face 3.0×10^{4}*	Permanent, not a surface treatment. Prevents build up or retention of dangerous electrostatic charges.

* Only the face (black) side of "LECTROLITE duotone fabric is conductive.

FABRICATION: Capable of being fabricated by stitching, welding and/or cementing - can be patched, seamed and repaired
COLOR: Permanent, non-fading, non-bleeding
WIDTH: Widths of 39.5", 54" or as specified.
IDENTIFICATION: 'LECTROLITE logo edgeprinted on fabric.
MAINTENANCE: Only necessary to wipe down with mild soap suds, rinse with warm water, when soiled. Disinfection, if required, follow manufacturers' recommended instructions for disinfectant used.

NOTE: Only 'LECTROLITE PREMIUM style ticking fabric should be used in direct or prolonged contact with cold cure (HR) and other highly extractive foams.

PROJECT NO. _____ DATE: 8/2/90
SUBJECT: MATERIAL SAFETY DATA SHEET (MSDS): LECTROLITE

LABORATORY REPORT

I. PRODUCT IDENTIFICATION

Product name: LECTROLITE
Description: Laminate Vinyl-Synthetic Fabric
Manufacturer: Herculite Products, Inc.
Address: P.O. Box 786, York, Pa. 17405

II. INGREDIENTS

The precise composition of this product is proprietary. While several of its components could be considered hazardous in pure form, none is significantly hazardous as compounded, due to dilution, encapsulation, etc. Under conditions of combustion, toxic gases, including hydrogen chloride and phthalic anhydride, are generated.* The major antibacterial agent Microban B® is a chlorinated phenoxy compound with extremely low toxicity to mammals (oral LD50 = 3700mg/kg). At concentrations present in LECTROLITE, it is not an irritant to eyes or skin. Barium (Ba), Cadmium (Cd) and Zinc (Zn) are present in very low concentrations (of the order of 500 ppm). Various pigment systems contain lead chromate yellow and molybdate orange. Low concentrations (less than 5%) of aluminum and antimony oxides are present as flame retardants.

*Nylon-containing styles generate small amounts of hydrogen cyanide in combustion.

III. PHYSICAL DATA

Boiling point: >500°F
Melting point: (approx.) 370°F
Specific gravity: (approx.) 1.25
Vapor pressure: (392°F): >1.1 mmHg
Vapor density: > 10 (Air = 1)
Solubility in H_2O: .005 (% by weight)
%Volatiles by volume: (approx.) 25 (High temp. only)
Evaporation rate: (approx.) 0 @ room temp. (butyl acetate = 1)
Appearance and odor: laminated vinyl-synthetic fabric; little or no odor.

IV. FIRE AND EXPLOSION DATA

Flash point: 450°F C.O.C.
Autoignition temp.: 520°F
Extinguishing media: water, CO_2, chemical.
Special fire fighting procedures:
Unusual fire and explosion hazard: releases HCl when burned
No explosion hazard. Nylon-containing styles release small quantities of HCN.

V. HEALTH HAZARD INFORMATION

The only significant hazards from this product arise under conditions of combustion or elevated temperatures (approximately 250°F and above), due to evolution of gases and vapors, including hydrogen chloride, phthalic anhydride, oxides of carbon, and minute amounts of vapor-phase heavy metals, including cadmium, antimony, lead, chromium, molybdenum, and barium. Nylon-containing styles evolve hydrogen cyanide. Individual sensitivities of an alergic nature cannot be predicted. In case of exposure to combustion gases, remove to fresh air, flush eyes and accessible mucous membranes with water, and consult physician if difficulty in breathing or burning sensation in chest is experienced.

VI. REACTIVITY DATA

Product is stable at normal use temperature, but may liberate HCl gas at temperatures from 250°F to 400°F depending on exposure time. Liberates HCl under pyrolysis conditions. Hazardous polymerization will not occur.

VII. SPILL OR LEAK PROCEDURES

No spill or leak hazard. Scrap can be landfilled. Consult local and federal regulations.

VIII. SPECIAL PROTECTION INFORMATION

Heat processing areas should be well ventilated. Under fire conditions, evolution of toxic gases necessitates eye, skin and respiratory protection.

IX. TRANSPORTATION DATA

National Motor Freight Classification (NMFC) 49210, Class 65, Flash Point: 450°F.

X. SPECIAL PRECAUTIONS

Temperature range for storage: -40°F to 150°F.

XI. DISCLAIMER

The information provided herein is true and accurate to the best of our knowledge. Although compiled by competent technical personnel, no guarantee or warranty is herein expressed or implied, as to the completeness or correctness thereof. Since the exact conditions of use of our products are beyond our control, any liability with regard to such use is hereby disclaimed. Nothing herein is to be taken as advising the infringement of any patent, or violation of any legal statute.

Larry D. Rinehart
Technical Director

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